

## COLLEMBOLA IN AMBER FROM THE DOMINICAN REPUBLIC

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*Abstract.*—The following taxa are reported from a collection of Collembola preserved in early Miocene amber from the Dominican Republic: Family Isotomidae—*Cryptopygus*, *Isotoma* (*Desoria*); Family Entomobryidae—*Lepidocyrtus*, *Pseudosinella*, *Seira*, *Salina*, *Paronella*, *Cyphoderus* (first fossil record for the genus); Family Sminthuridae—*Sphyrotheca*. One group of blind isotomids tentatively identified as *Isotoma* (*Desoria*) probably represent a new genus. Forty-three percent of the specimens belong to *Lepidocyrtus* and *Seira*. Overall morphology indicates that this springtail fauna is remarkably modern and very similar to that of Miocene amber from Chiapas, Mexico. Six photographs and 37 drawings complement the descriptive notes.

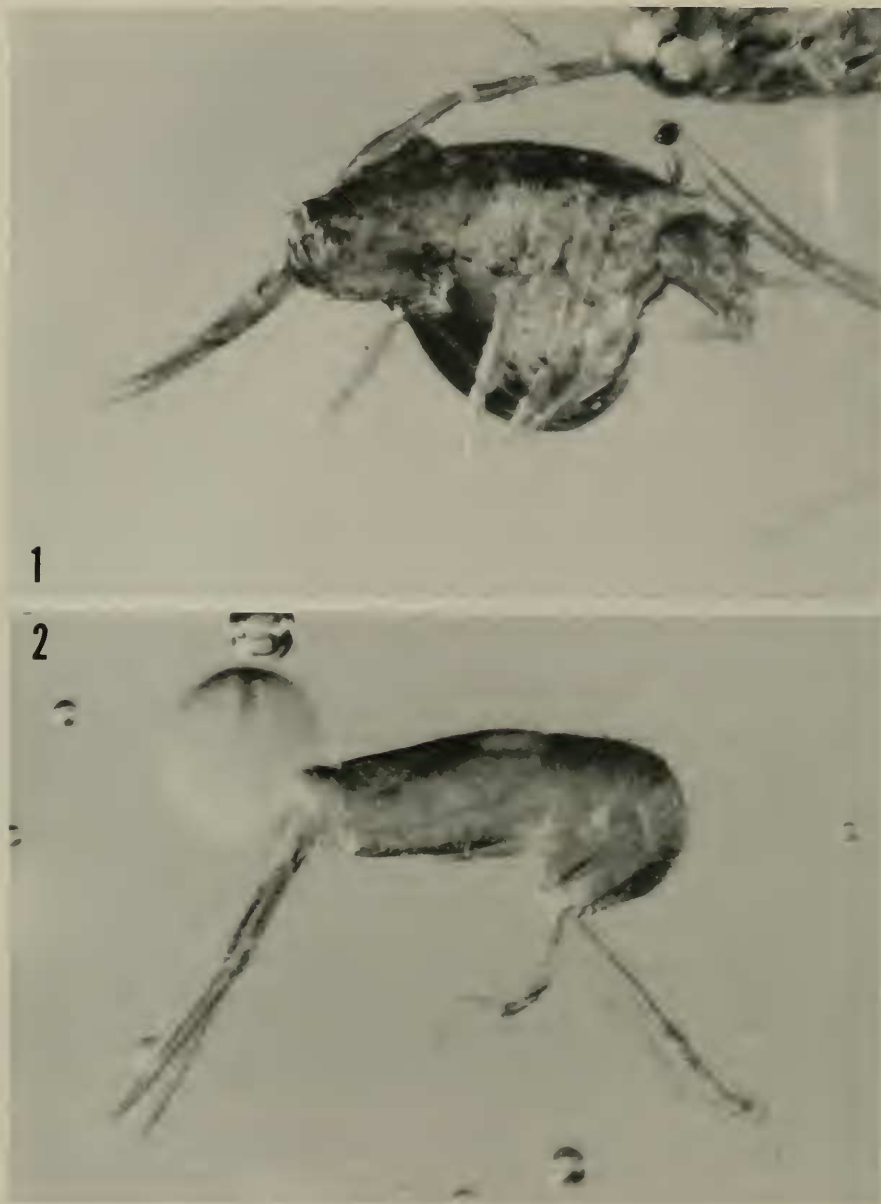
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Tropical fossil Collembola are known only from a contribution by Christiansen (1971), who studied 70 specimens preserved in Miocene amber from the State of Chiapas, Mexico. This author was able to place 34 of the specimens into seven genera and, with some degree of doubt, identify seven species which are still extant.

Herein I report the study of 90 springtails preserved in amber from the Dominican Republic. The insects belong to nine living genera, although a group of isotomids probably represent a new genus. Although several specimens are very well preserved, many relevant morphological details remain obscured and it has not been possible to reliably distinguish these insects from extant forms or assign them to living species. Overall morphology strongly suggests, however, that an essentially modern collembolan fauna was established in the Dominican Republic by Tertiary times.

Baroni-Urbani and Saunders (*in press*) have estimated the age of substrate taken at the Palo Alto amber mines, north of Santiago. From the study of their foraminiferan faunas, the three samples were assigned an age of 20–23 million years (lower early Miocene). This age must be considered as minimum because, as Brouwer and Brouwer (1980) pointed out, the amber has undergone extensive redeposition since its formation. The present association with sediments that bear marine organisms must have occurred at a later date.

Amber studied for the present investigation was purchased from Mr. Jacob Brodzinsky, AmERICA Inc., Santo Domingo, Dominican Republic. According to Mr. Brodzinsky, most of the fossil-bearing amber he obtains is extracted from mines in the northern mountain range between Santiago and Puerto Plata. However, since amber may change hands repeatedly on its way to Santo Domingo, it is not possible to determine from which particular mine it was removed.



Figs. 1, 2. 1, *Cyphoderus* sp. (37). 2, *Salina* sp. (22).

The complete collection of springtails is temporarily deposited at the Entomological Research Laboratory, University of Puerto Rico, Mayagüez. A number has been assigned to each piece and is given in parentheses throughout the taxonomic section and in the legends for the figures.

#### METHODS

It is very difficult to study small structural details of springtails preserved in amber unless a substantial amount of resin surrounding the specimen is removed.



Figs. 3, 4. 3, *Pseudosinella* sp. (16). 4, *Seira* sp. (5).

The small working distance of high magnification objectives demands that the specimen be brought as close to the surface of the amber as possible. The amber piece should also be thin so that enough light passes through without undue reflections or distortions from bubbles or debris.

Amber was sectioned with a 10 cm diameter, 0.2 mm thick Elgin copper diamond blade mounted on the shaft of an electric motor rated at 1725 rpm. Resulting pieces were sanded along desired planes on a small wooden wheel covered with 400 grit sandpaper. Polishing was accomplished by a dry rotating cloth wheel impregnated with Menzema Werk beige-colored polishing compound (distributed to amber shops in Santo Domingo by Brouwer Dental Supply Company). The sanding and polishing wheels were mounted on a belt-driven axle connected to

a similar electric motor. Almost all the drawings in this paper were made while using a Leitz oil immersion objective on amber sections less than 1 mm thick.

Surface details of the head and body (especially eyes, postantennal organ, and tenaculum) are more readily observed by complementing the substage light of the compound microscope with surface illumination from one or more high-intensity illuminators. Coating the amber with immersion oil renders invisible many surface imperfections and is recommended for photography and for the study of amber that has not been adequately polished.

#### DESCRIPTIVE NOTES AND COMMENTS

##### FAMILY ISOTOMIDAE

##### Genus *Cryptopygus* Willem

Two specimens (30, 32) isolated from the same piece of amber belong to this genus. Length approximately 0.38 mm. Body covered by smooth setae markedly longer on last abdominal segment (Fig. 7). Mucro and claws (Figs. 8, 10) typical of genus. Eyes g and h reduced (Fig. 9), postantennal organ (PAO) large and oval-shaped.

##### Genus *Isotoma* Bourlet

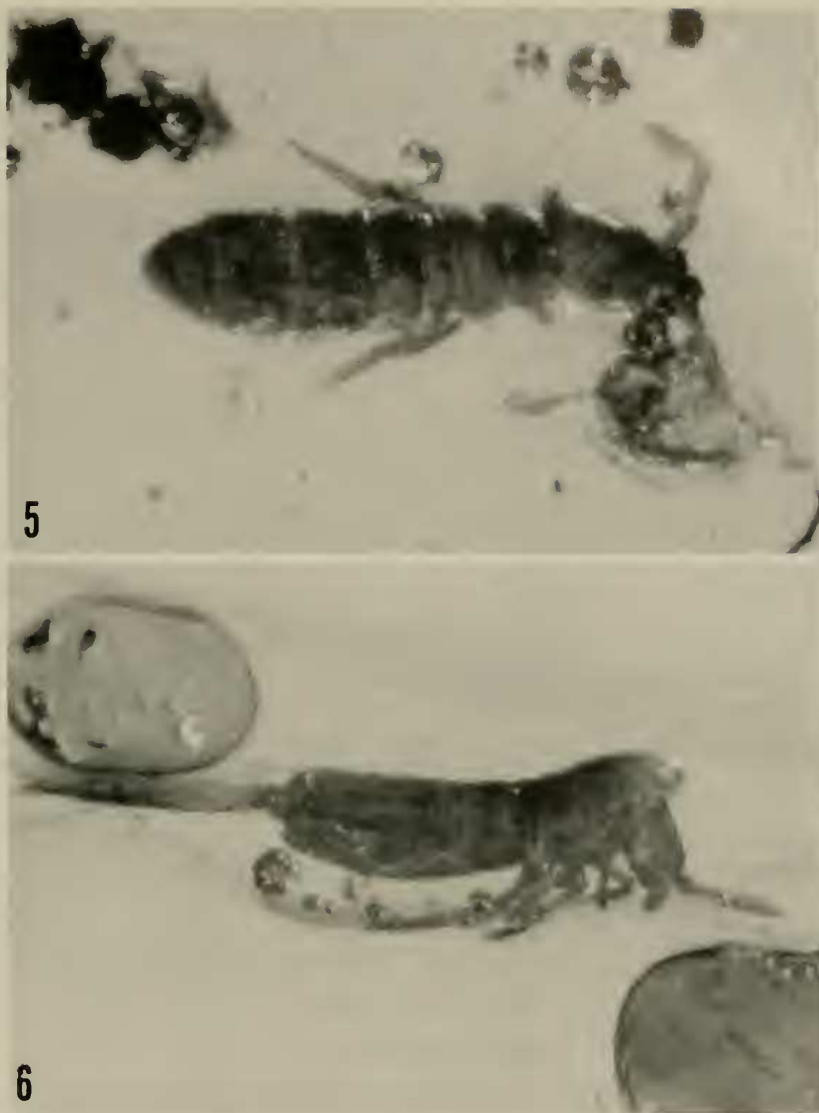
*Isotoma* (*Desoria*) sp. 1.—This species is represented by two specimens, one of which (33) is in very poor condition and the only observation possible is its length (0.68 mm). The second individual (Fig. 5, no. 31) measures 0.62 mm and has the fifth and sixth abdominal segments clearly separated. Body covered by smooth setae, bothriotricha absent. Several eyes visible, mucro with 2 teeth in line and a lateral tooth. Directed forwards, furcula almost reaches colophore; dorsal portion of dentes crenulated. Claw structure as in Fig. 11.

*Isotoma* (*Desoria*) sp. 2.—Eighteen specimens in one amber piece (37) belong to a species with the following unusual combination of characters: Eyes absent, PAO present (Fig. 12), fifth and sixth abdominal segments fused (Fig. 16), and body clothed only by short smooth setae. Furcula reaches forwards to colophore, manubrium and dentes with many short smooth setae but no spines or spinelike setae, dentes dorsally crenulate, mucro with 3 teeth (Fig. 13), corpus of tenaculum with at least 8 setae and rami with at least 3 teeth (Fig. 15), claws devoid of teeth (Fig. 17). Largest specimen measures 1.6 mm.

The aforementioned characters place this species in *Isotoma*, subgenus *Desoria*, as defined by Christiansen and Bellinger (1980), although it is clearly not a typical member of the taxon. Only two of the 41 Nearctic species in this subgenus lack eyes and both have the fifth and sixth abdominal segments separated. Types of body setae, claw structure, and mucronal morphology also separate the Dominican specimens from both Nearctic forms.

Judging from Stach (1947: 365) the Holarctic *Isotoma sphagneticola* Linnanieni has a combination of characters similar to those of the amber fossils. However, Gisin (1960) and Grindbergs (1960) placed this species in the genus *Cryptopygus* (as *Isotomina*) and the former called it a *species inquirenda*. Christiansen and Bellinger (1980) regarded the species as "unplaceable without types."

The Dominican specimens could be referred to *Pseudosorensia* Izarra 1972, a genus erected for a species from Tierra del Fuego, Argentina. However, individuals



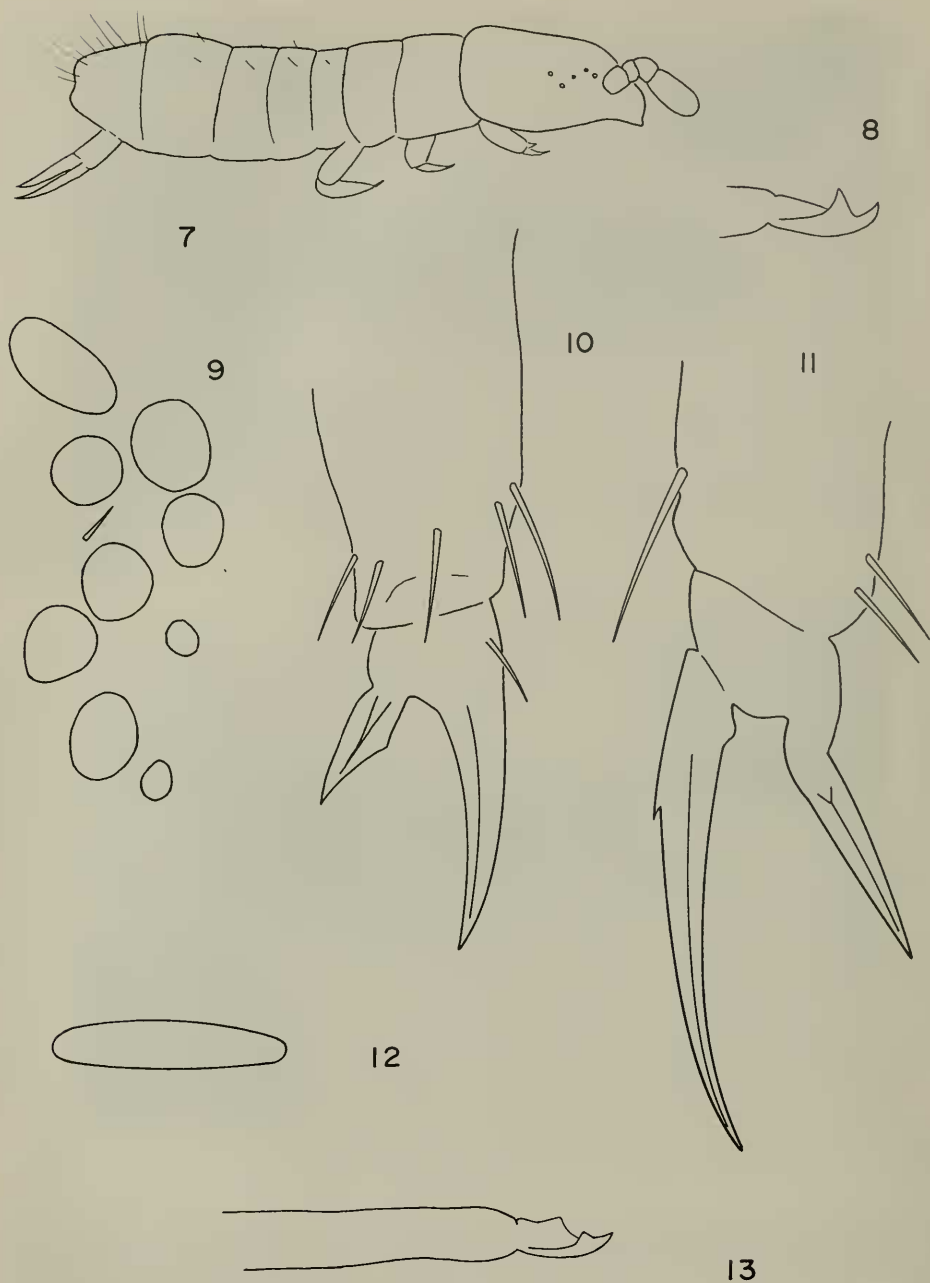
Figs. 5, 6. 5, *Isotoma* (*Desoria*) sp. 1 (31). 6, *Lepidocyrtus* sp. (21).

of *P. fueguensis* possess one eye, a much wider PAO, spinelike setae on the head and body, and some of the body setae are ciliated. The amber fossils very likely represent a new genus but I hesitate to define such a taxon until a general consensus on the limits of *Isotoma* and several other genera of Isotominae is reached.

#### FAMILY ENTOMOBRYIDAE

#### Genus *Lepidocyrtus* Bourlet

Twenty specimens distributed among 11 pieces (17–21, 37–42) belong in this taxon. Individuals range in length from 0.46 to 1.0 mm and lack macrochaetae.



Figs. 7-13. 7-10, *Cryptopygus* sp. 7, Habitus (30). 8, Mucro (32). 9, Eyes and postantennal organ (32). 10, Claws (32). 11, *Isotoma* (*Desoria*) sp. 1, claws (33). 12, 13, *Isotoma* (*Desoria*) sp. 2. 12, Postantennal organ (37). 13, Mucro (37).

Most specimens have a well developed mesothoracic hood (Fig. 6). The five individuals in piece 39 range in size from 0.50 to 0.68 mm and demonstrate a direct relation between increase in overall length and the size of the hood. Some specimens possess a short mucronal spine (Figs. 20, 21) while others have the spine more strongly developed (Fig. 19).

### Genus *Pseudosinella* Schaeffer

One specimen (Fig. 3) in piece 16 belongs to this genus. Length 0.74 mm. Scales hyaline, some macrochaetae along anterior margin of mesonotum, no thoracic hood. Mucro (Fig. 18) with long basal spine.

### Genus *Seira* Lubbock

Nineteen specimens in as many pieces (1–15, 27–29, 36) represent this taxon. They range in length from 0.64 to 1.67 mm and most can be readily distinguished from the preceding entomobryids by the many macrochaetae along the anterior margin of the mesonotum and on the rest of the thorax. Mucronal structure (Fig. 25) is also characteristic. Scales usually conspicuous (Fig. 4) and strongly striated. Long tenent hairs (Figs. 22, 24) on all legs. Arrangement of eyes (Fig. 23) observed in one individual.

### Genus *Salina* MacGillivray

The seven specimens preserved in six pieces (22–24, 41–43) measure 0.90 to 1.60 mm and belong to a species with tridentate mucrones and apically pointed dental scalelike lobe (Figs. 26, 27). A truncate unguiculus (Fig. 28) is visible in one leg of one specimen. Habitus (Fig. 2) typical of genus.

Christiansen (1971) identified as *Salina tristani* two specimens in amber from Chiapas with mucrones very similar to those of individuals in Dominican amber. I have studied 26 Puerto Rican specimens of *S. tristani* and in these the mucro bears a minute but distinct fourth tooth on one of the lamellae (see Denis 1931: 150 or Mari Mutt 1976: 117). Since other species of *Salina* have tridentate mucrones and the extant springtail fauna of the Dominican Republic is essentially unknown, it is undesirable to assign specific status to the fossils under study.

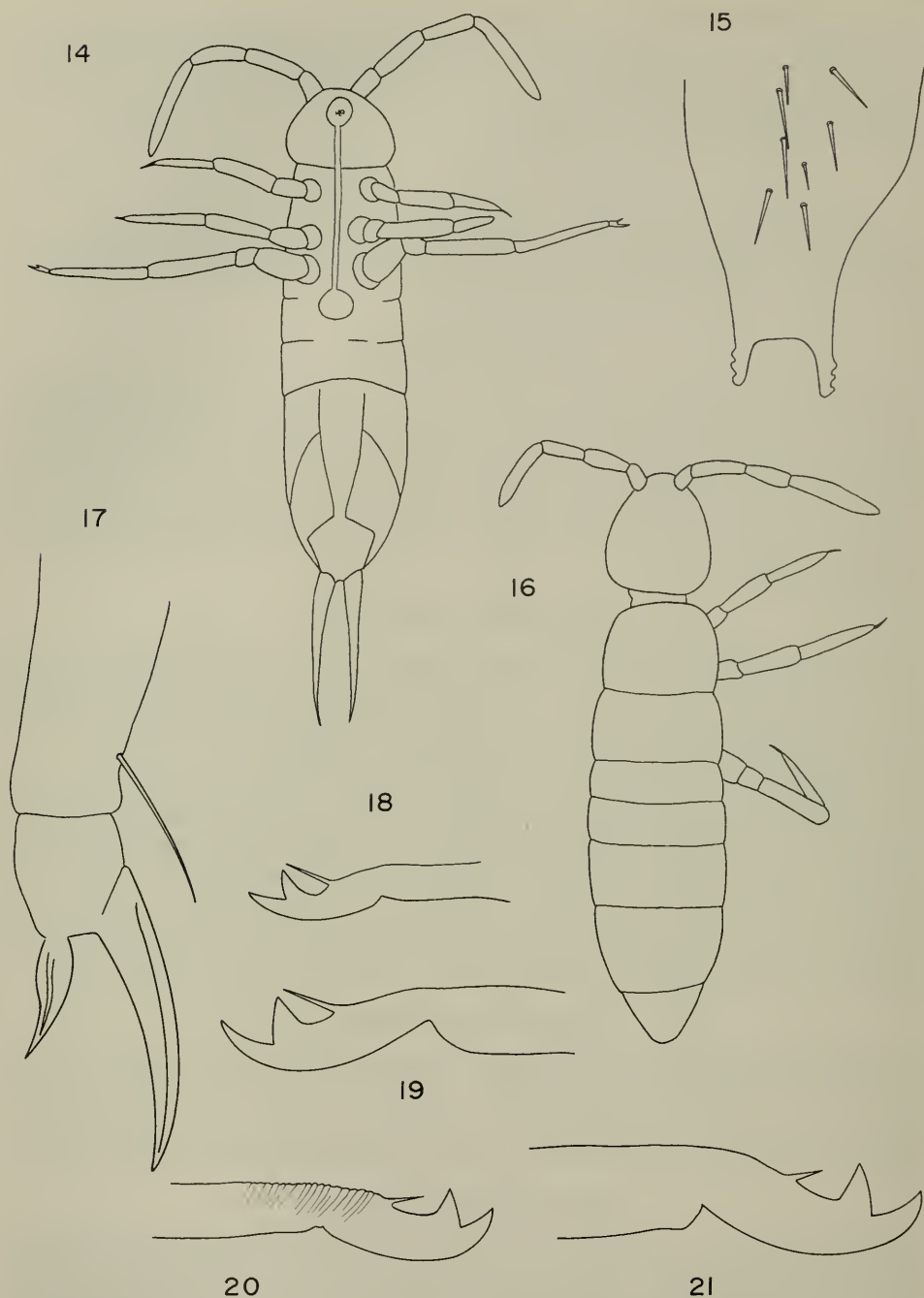
### Genus *Paronella* Schött

Three specimens (25, 26, 44) belong to this genus. In habitus (Fig. 29) they resemble individuals of the preceding genus but the antennae are shorter and the mucro (Figs. 30–32) is very different. A metathoracic unguiculus is visible and is long and acuminate, not dilated as in *Salina*. Specimens measure 0.81–0.85 mm.

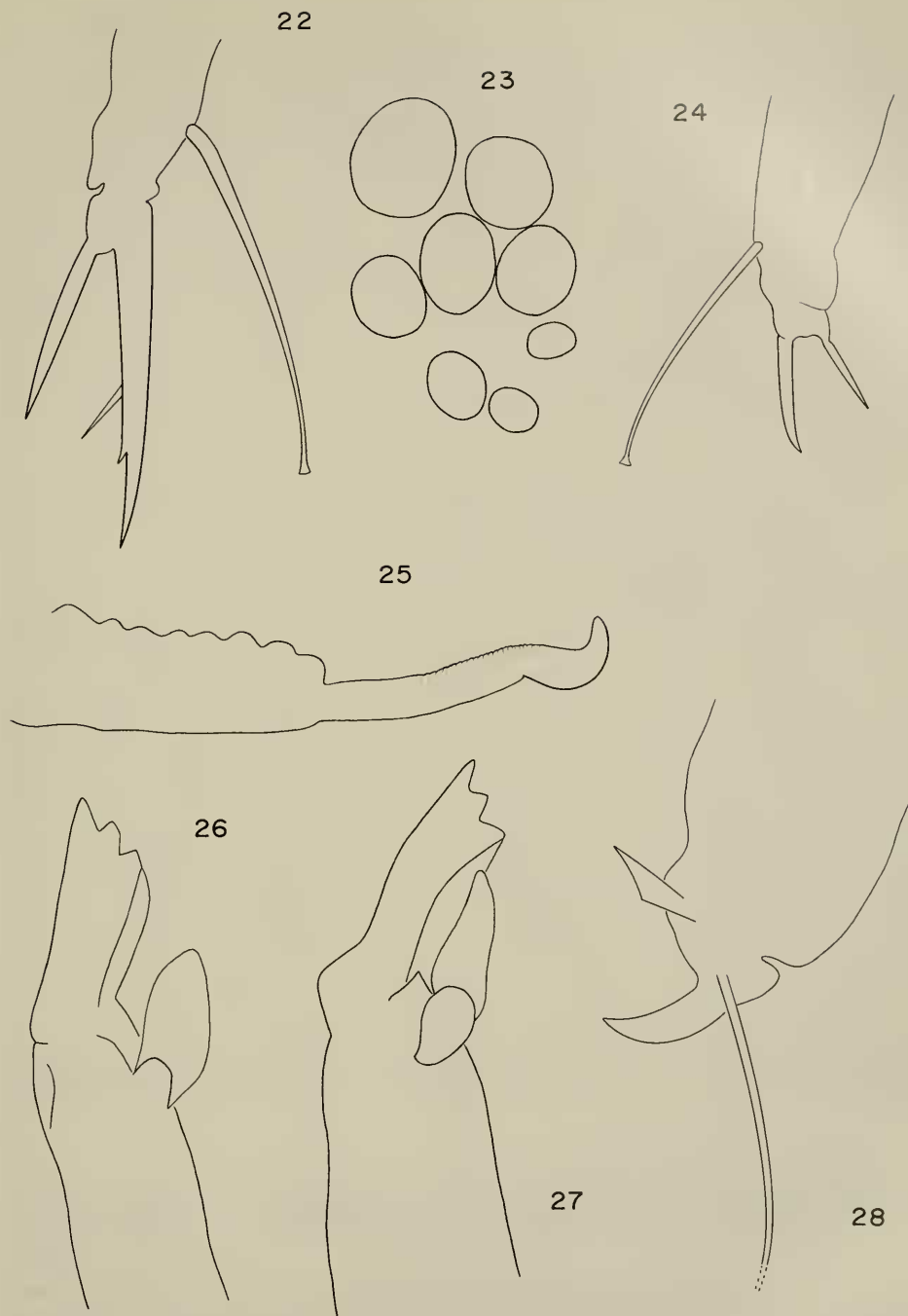
### Genus *Cyphoderus* Nicolet

*Cyphoderus* sp. 1.—Fourteen specimens in the same amber piece (37) belong to a species recognized by short antennae (Figs. 1, 39) and mucrones with up to 8 teeth (Figs. 35, 36). The largest specimen measures 1.06 mm. Claw structure (Fig. 40) visible in a metathoracic leg of one specimen. A direct relation exists between overall length of the specimens and number of mucronal teeth (Figs. 33–36).

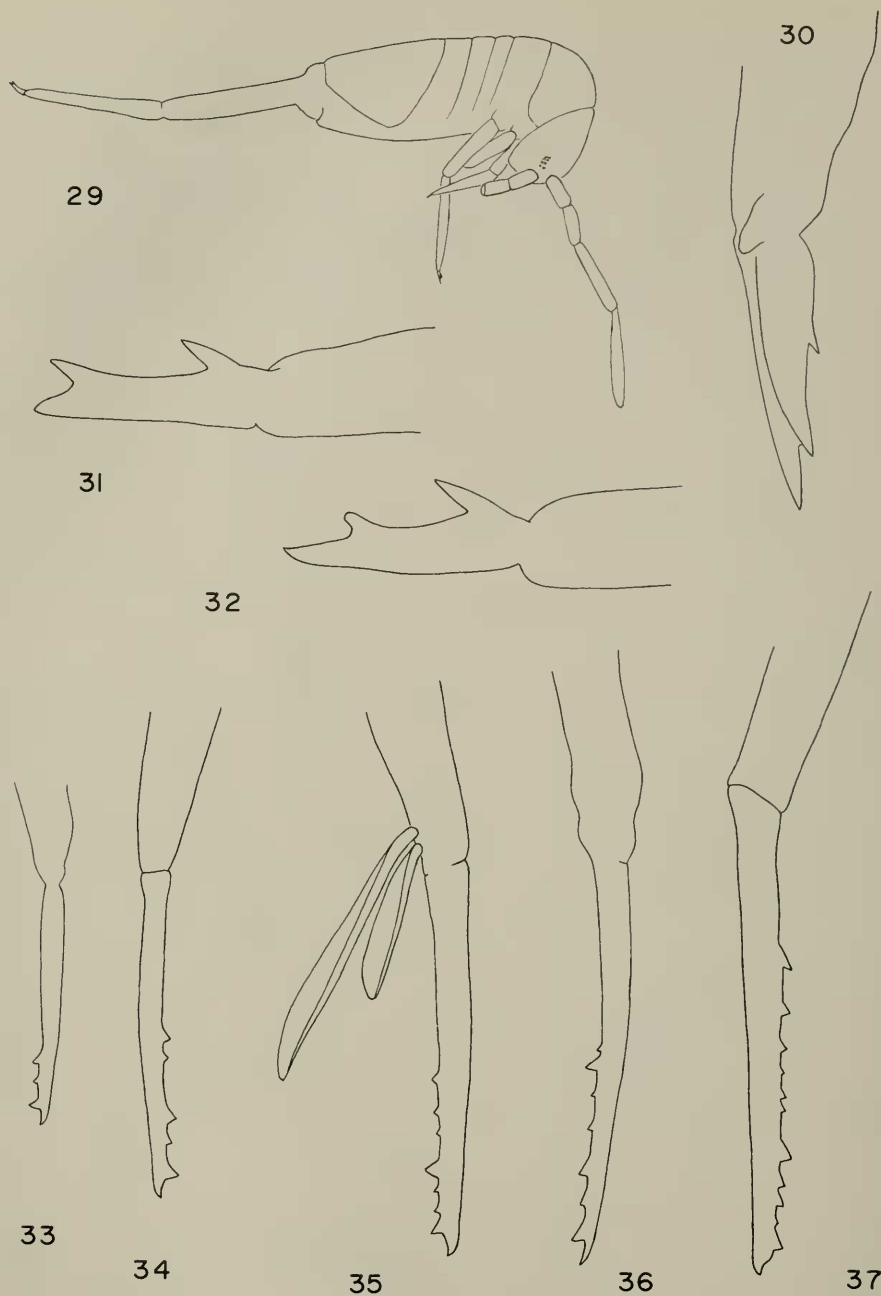
*Cyphoderus* sp. 2.—Amber piece 37 also houses two specimens of a different



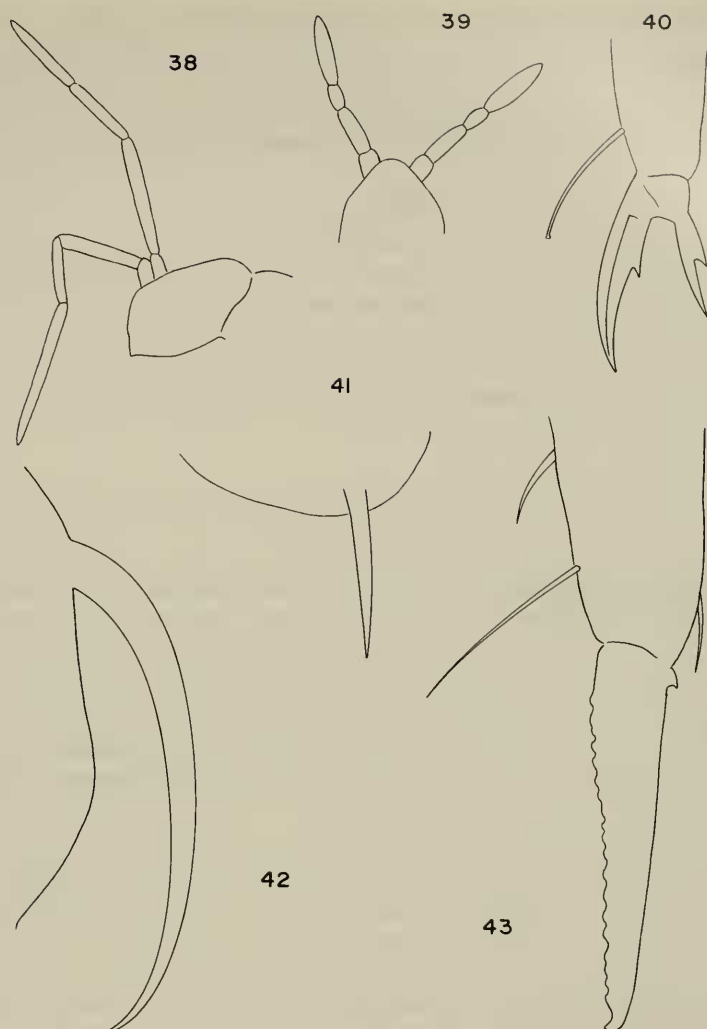
Figs. 14–21. 14–17, *Isotoma (Desoria)* sp. 2; all drawings from amber piece 37. 14, Habitus, ventral view. 15, Tenaculum. 16, Habitus, dorsal view. 17, Claws. 18, *Pseudosinella* sp., mucro (16). 19–21, *Lepidocyrtus* sp., mucrones (18, 21, 38).



Figs. 22–28. 22–25, *Seira* sp. 22, Claws (10). 23, Eyes (3). 24, Claws (3). 25, Mucro (11). 26–28, *Salina* sp. 26, 27, Mucrones (22, 43). 28, Claws (24).



Figs. 29–37. 29–32, *Paronella* sp. 29, Habitus (44). 30–32, Mucrones (26, 44). 33–36, *Cyphoderus* sp. 1; all drawings from specimens in amber piece 37; from left to right, individuals with these structures measure 0.55, 0.96, 1.06, and 1.04 mm. 37, *Cyphoderus* sp. 2, mucro of specimen measuring 1.26 mm (37).



Figs. 38–43. 38–40, *Cyphoderus* sp. 2. 38, Relative lengths of antennae and head (37). 39, As preceding (37). 40, Claws (37). 41–43, *Sphyrotheca* sp. 41, Trochanteral spine (35). 42, Subanal appendage (34). 43, Mucro (35).

species. These individuals possess much longer antennae (Fig. 38), measure up to 1.26 mm, legs are somewhat longer, and mucrones have 10–12 teeth (Fig. 37). Like all extant *Cyphoderus*, these fossils lack eyes.

#### FAMILY SMINTHURIDAE

#### Genus *Sphyrotheca* Börner

Two individuals (34, 35) belong to this genus, which is readily recognized by strong spinelike setae on head and body and large trochanteral spine (Fig. 41). A specimen in piece 34 measures 1.04 mm and is a female with a conspicuous

subanal appendage (Fig. 42). Thick ungues suggest presence of tunica, mucro with minute serrations on both lamellae. Fourth antennal segment with 11 subsegments.

The specimen in piece 35 measures 0.46 mm and apparently is a male. Mucro with conspicuous serrations in at least one lamella (Fig. 45).

#### DISCUSSION

Amber piece 37 is outstanding in harboring all the specimens of *Cyphoderus* and of the unusual *Isotoma* (*Desoria*) sp. 2. The former taxon is herein reported from fossils for the first time. The vast majority of cyphoderines are commensals in ant and termite nests and the presence of these fossils in Dominican amber indicates that this partnership has existed for a long time. The occurrence of the eyeless *Isotoma* in this same piece suggests that the latter may have also been a commensal and that these insects were perhaps trapped by resin flow from the roots of a tree located near a nest.

A comparison of the springtails in Dominican amber with those in amber from Chiapas studied by Christiansen (1971) suggests that both contemporary faunas were very similar and probably closely related. Christiansen reported seven genera, and, of these, *Seira* (as *Lepidocyrtinus*), *Lepidocyrtus*, *Salina*, *Paronella* and *Cryptopygus* (as *Isotomina*) occur in Dominican amber. The only significant difference between both groups is that in the Mexican resin the dominant genus in terms of number of specimens is *Entomobrya* while in Dominican amber this distinction is shared by *Lepidocyrtus* and *Seira* (43% of the specimens). Neither *Entomobrya* nor *Isotomurus*, also reported by Christiansen, have been discovered in Dominican amber, but both surely live today in the Dominican Republic and may be discovered during study of additional amber.

With respect to ants preserved in Dominican amber, Baroni-Urbani and Saunders (*in press*) state: "A quick overview of this fauna shows a typical Neotropical fascies not very far from what one would expect from a random sample taken in a Dominican forest today." This observation also applies to the Collembola reported herein. With the possible exception of *Isotoma* (*Desoria*) sp. 2, all other species are very likely either alive today or have their closest descendants in the extant fauna of the Dominican Republic.

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#### BOOK REVIEW

*An Introduction to Biological Control*. By R. van den Bosch, P. S. Messenger, and A. P. Gutierrez. Plenum Press, New York and London. 247 pp., illus., 1982. Cost: \$18.95, hardback.

This volume, a revision of *Biological Control* by R. van den Bosch and P. S. Messenger, is intended as an undergraduate textbook. It serves this function well, being written in straightforward, simple language, with ample and usually good definitions of the many terms and concepts needed for understanding this complex subject. Chapters include: the nature and scope of biological control, with emphasis on control of insects and weeds by insects, the ecological basis for biological control, history and international development, examples of insect predators and parasites, use of pathogens and nematodes in biological control, procedures for introducing and culturing natural enemies, application of life tables, factors limiting success, some examples of classical biological control, natural control and integrated pest management, biological control of vertebrates and their dung, some examples of competitive and cultural pest control, economics of biological control, and future prospects.

In general, except for a few "typos," the text is excellent, and the tables and diagrams are very good and useful. Many photographs should have been omitted because they detract from the text, in particular, several pictures of nonspecific predators, duplications, and those which were too dark or indistinct to show the subject. The apparently inadvertent use of boldface type on several scattered pages is distracting; this obvious mistake should have been corrected in proof.

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